Third United Nations International Conference on the Peaceful Uses of Atomic Energy

A/CONF.28/A/177
UNITED KINGDOM
February 1964
Original: ENGLISH

Confidential until official release during Conference

Abstract

A STUDY OF FUEL CYCLES AND FUEL CYCLE PROBLEMS FOR ADVANCED GAS COOLED GRAPHITE MODERATED REACTORS

by

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1. The Advanced Gas-Cooled Graphite Moderated Reactors, like the Magnox Reactors already under construction, will have facilities for fuel replacement on-load. The advantage of this facility apart from the maintenance of a high load factor is that the average core properties in each region of the reactor may be maintained sensibly constant; since the addition of new fuel is counter-balanced by the removal of fully burnt fuel and the changes in fuel properties generally with irradiation. Because the average properties of each region of the reactor are maintained constant the macroscopic flux and power distributions will also remain unchanged during irradiation though the power generated by each piece of fuel (and therefore each channel) will vary as burn-up proceeds.

2. As fuel is irradiated the reactivity it is able to provide in the reactor decreases because of the general burn-out of the fissile elements, the accumulation of fission product poisons and the formation of ^{240}Pu and ^{242}Pu. However, because each region contains fuel at all irradiation levels it is possible to balance the excess neutron production of fresh fuel against the defficiencies of fuel which is almost fully burnt-up. The feed enrichments are therefore reduced well below what would be required if the reactor operated as a whole batch and of course the average irradiation of the fuel approaches closely the maximum that the fuel can stand from an endurance point of view.

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The feed enrichments for a reference design of Advanced Gas-Cooled Reactor are given as follows.

Enriched Uranium fuels		
Critical enrichment	% ^{235}U	1.35
Feed enrichment for 12000 MWD/Te	% ^{235}U	1.68
Feed enrichment for 20000 MWD/Te	% ^{235}U	2.05
Natural uranium and magnox plutonium		
Critical fuel	Kg/Te Pu	3.3
Feed for 12000 MWD/Te	Kg/Te Pu	10.9
Feed for 20000 MWD/Te	Kg/Te Pu	18.5

3. The properties of the reactor in the equilibrium condition are easily established. However, disturbances from this condition will always exist because it will be necessary to change the reactor from a fresh-fuelled state at the start of life to the equilibrium state. This process will take several years. Furthermore improvements in fuel endurance during reactor life and changes in the cost of fissile materials call for a change in the target irradiation or even of the fissile elements used. The effects of such changes on the fuel utilisation and on the ratio of peak to average channel power output need to be known at an early stage since they have some influence on the design of the reactor.